

***What Is Claimed Is:***

1. An angle rotator for rotating an input complex number to produce a rotated complex number according to an input angle  $\theta$ , said angle rotator comprising:

a memory that stores a  $\sin \theta_M$  value and a  $\cos \theta_M$  value, wherein  $\theta_M$  is a coarse approximation to said input angle  $\theta$ ;

a first digital circuit that performs a coarse rotation on said input complex number based on said  $\sin \theta_M$  value and said  $\cos \theta_M$  value, resulting in an intermediate complex number;

a fine adjustment circuit that generates a fine adjustment value based on a  $\theta_L$  value, wherein  $\theta_L = \theta - \theta_M$ ; and

a second digital circuit that performs a fine rotation on said intermediate complex number based on said fine adjustment value, resulting in the rotated complex number.

2. The angle rotator of claim 1, wherein said fine adjustment value is  $(1 - \theta_L^2/2)$ .

3. The angle rotator of claim 1, wherein said first digital circuit is a butterfly circuit having a plurality of multipliers that multiply said input complex number by said  $\sin \theta_M$  value and said  $\cos \theta_M$  value.

4. The angle rotator of claim 1, wherein said second digital circuit is a butterfly circuit having a plurality of multipliers that multiply said intermediate complex number by said fine adjustment value.





17. The angle rotator of claim 16, wherein said first error value is represented by  $\delta_{[\cos \theta_1]}$  as defined by the following equation:

$$\frac{1}{\sqrt{[\cos \theta_1]^2 + (\sin \theta_1)^2}} = 1 + \delta_{[\cos \theta_1]}.$$

18. The angle rotator of claim 9, wherein  $\theta_1$  is an arcsin of said first value, wherein said one or more error values include a second error value that represents  $(\theta_M - \theta_m)$ , wherein  $\theta_m = \arctan (\sin \theta_1 / \text{second value})$ .

19. The angle rotator of claim 18, further comprising an adder that adds said second error value to  $\theta_L$  to produce a  $\theta_i$  value, wherein  $\theta_L$  is a radian angle associated with a least significant word (LSW) of said input angle.

20. The angle rotator of claim 19, wherein said angle rotator further comprises a fine adjustment circuit coupled to said second digital circuit, wherein said fine adjustment circuit generates a fine adjustment value based on  $\theta_i$  and said first error value.

21. The angle rotator of claim 20, wherein said fine adjustment value controls said fine angle rotation in said second digital circuit.

22. The angle rotator of claim 20, wherein said fine adjustment value is approximately: first error value -  $(\frac{1}{2} \cdot \theta_i^2)$ .

23. The angle rotator of claim 20, wherein said second digital circuit includes a plurality of multipliers.

1 *Sub*  
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24. The angle rotator of claim 23, wherein said plurality of multipliers multiply said intermediate complex number by said  $\theta_i$  value.

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25. The angle rotator of claim 23, wherein said plurality of multipliers multiply said intermediate complex number by said fine adjustment value.

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26. An angle rotator for rotating an input complex number to produce a rotated complex number according to an input angle, said angle rotator comprising:

4 a memory that stores one or more values indexed by a most significant  
5 word (MSW) of said input angle, including

6 a first value that is an approximation of a  $\tan \theta_M$  value, and a  
7 second value that is an approximation of a  $\cos \theta_M$  value, wherein  $\theta_M$  is a radian  
8 angle that corresponds to said MSW of the input angle, and

9 one or more error values that represent one or more quantization  
10 errors associated with at least one of said first value and said second value;

11 a first digital circuit that rotates said input complex number based on said  
12  $\tan \theta_m$  value, resulting in an intermediate complex number; and

13 a second digital circuit that rotates said intermediate complex number so  
14 as to produce at least one part of the rotated complex number, based on said one  
15 or more error values and said second value, resulting in the rotated complex  
16 number.

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27. The angle rotator of claim 26, wherein  $\theta_m$  is an arctan of said first value, wherein said one or more error values include a first error value that represents  $\cos \theta_m$  - second value.

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28. The angle rotator of claim 26, wherein  $\theta_m$  is an arctan of said first value, wherein said one or more error values include a second error value that represents  $\theta_M - \theta_m$ .

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29. The angle rotator of claim 28, further comprising an adder that adds said second error value to  $\theta_L$  to produce a  $\theta_i$  value, wherein  $\theta_L$  is a radian angle associated with a least significant word (LSW) of said input angle.

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30. The angle rotator of claim 29, wherein said angle rotator further comprises a fine adjustment circuit coupled to said second digital circuit, wherein said fine adjustment circuit generates a fine adjustment value based on  $\theta_i$ , said second value, and said first error value.

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31. The angle rotator of claim 30, wherein said fine adjustment value controls said fine angle rotation in said second digital circuit.

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32. The angle rotator of claim 30, wherein said second digital circuit includes a plurality of multipliers.

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33. The angle rotator of claim 32, wherein said plurality of multipliers multiply said intermediate complex number by said  $\theta_i$  value.

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34. The angle rotator of claim 32, wherein said plurality of multipliers multiply said intermediate complex number by said fine adjustment value.

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35. In a digital device, a method of rotating an input complex number according to an input angle  $\theta$ , the method comprising the steps of:

(1) receiving the input complex number;

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(2) determining a first value that is an approximation of  $\sin \theta_M$ , and  
determining a second value that is an approximation of  $\cos \theta_M$ , wherein  $\theta_M$  is a  
radian angle that corresponds to a most significant word (MSW) of the input angle  
 $\theta$ ; and

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(3) rotating said input complex number in a complex plane based on  
said first value and said second value to generate a rotated complex number,  
whereby said rotated complex number is data processed by said digital device.

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36. The method of claim 35, wherein said step of determining comprises the  
step of retrieving said first value and said second value from a memory.

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37. The method of claim 35, wherein  $\theta_1$  is an arcsin of said first value, further  
comprising the step of:

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(4) determining a first error value that represents a difference between  
said second value and  $\cos \theta_1$ .

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38. The method of claim 37, further comprising the step of:

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(5) rotating said rotated complex number in said complex plane to  
generate a second rotated complex number based on said first error value.

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39. The method of claim 37, further comprising the step of:

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(5) determining a second error value that represents  $(\theta_M - \theta_m)$ , wherein  
 $\theta_m = \arctan(\text{first value/second value})$ .

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40. The method of claim 39, further comprising the step of:

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(6) adding said second error value to a  $\theta_L$  value to produce a  $\theta_i$  value,  
wherein  $\theta_L$  is a radian angle associated with a least significant word (LSW) of said  
input angle  $\theta$ .

41. The method of claim 40, further comprising the step of:

(7) generating a fine adjustment value based on said  $\theta_i$  value and said first error value.

42. The method of claim 41, wherein said fine adjustment value is approximately:

$$\text{first error value} - (\frac{1}{2} \cdot \theta_i^2).$$

43. The method of claim 41, further comprising the step of:

(8) rotating said rotated complex number according to said fine adjustment value and said  $\theta_i$  value.

44. The method of claim 43, wherein step (8) comprises the steps of:

(a) multiplying said rotated complex number by said fine adjustment value; and

(b) multiplying said rotated complex number by said  $\theta_i$  value.

45. In a digital device, a method of rotating an input complex number to produce a rotated complex number according to an input angle  $\theta$ , the method comprising the steps of:

(1) receiving the input complex number;

(2) determining a first value that is an approximation of  $\sin \theta_M$ , and determining a second value that is an approximation of  $\cos \theta_M$ , wherein  $\theta_M$  is a radian angle that corresponds to said MSW of the normalized input angle  $\theta$ ;

(3) rotating said input complex number in a complex plane based on said first value and said second value to generate an intermediate complex number;

(4) determining one or more error values that represent one or more quantization errors, including the steps of



- 12 *add*  
13 *an*  
14 *and*
- (a) determining a first error value that represents a difference  
between said second value and  $\cos \theta_1$ , wherein  $\theta_1$  is an arcsin of said first value,  
and
- 15 (b) determining a second error value that represents  $(\theta_M - \theta_m)$ ,  
16 wherein  $\theta_m = \arctan (\text{first value} / \text{second value})$ ;
- 17 (5) adding said second error value to a  $\theta_L$  value to produce a  $\theta_i$  value,  
18 wherein  $\theta_L$  is a radian angle associated with a least significant word (LSW) of said  
19 normalized input angle  $\theta$ ;
- 20 (6) generating a fine adjustment value based on  $\theta_i$  and said first error  
21 value; and
- 22 (7) rotating said intermediate complex number in said complex plane  
23 to generate the rotated complex number based on said  $\theta_i$  value and said fine  
24 adjustment value, whereby the rotated complex number is data processed by the  
25 digital device.
- Add an*